# What Pervasive Computing Brings to Automotive Consumer Experiences, Services, Products & Processes

K. Venkatesh Prasad
Infotronics Technologies Group
Ford Research Laboratory
Ford Motor Company
Dearborn, Michigan
kprasad@ford.com

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Ford Motor Company

VOLVO mazda LINCOLN Ford Mercury JAGUAR ASTON MARTIN LAND ROVER

# What's Pervasive in the context of Computing?

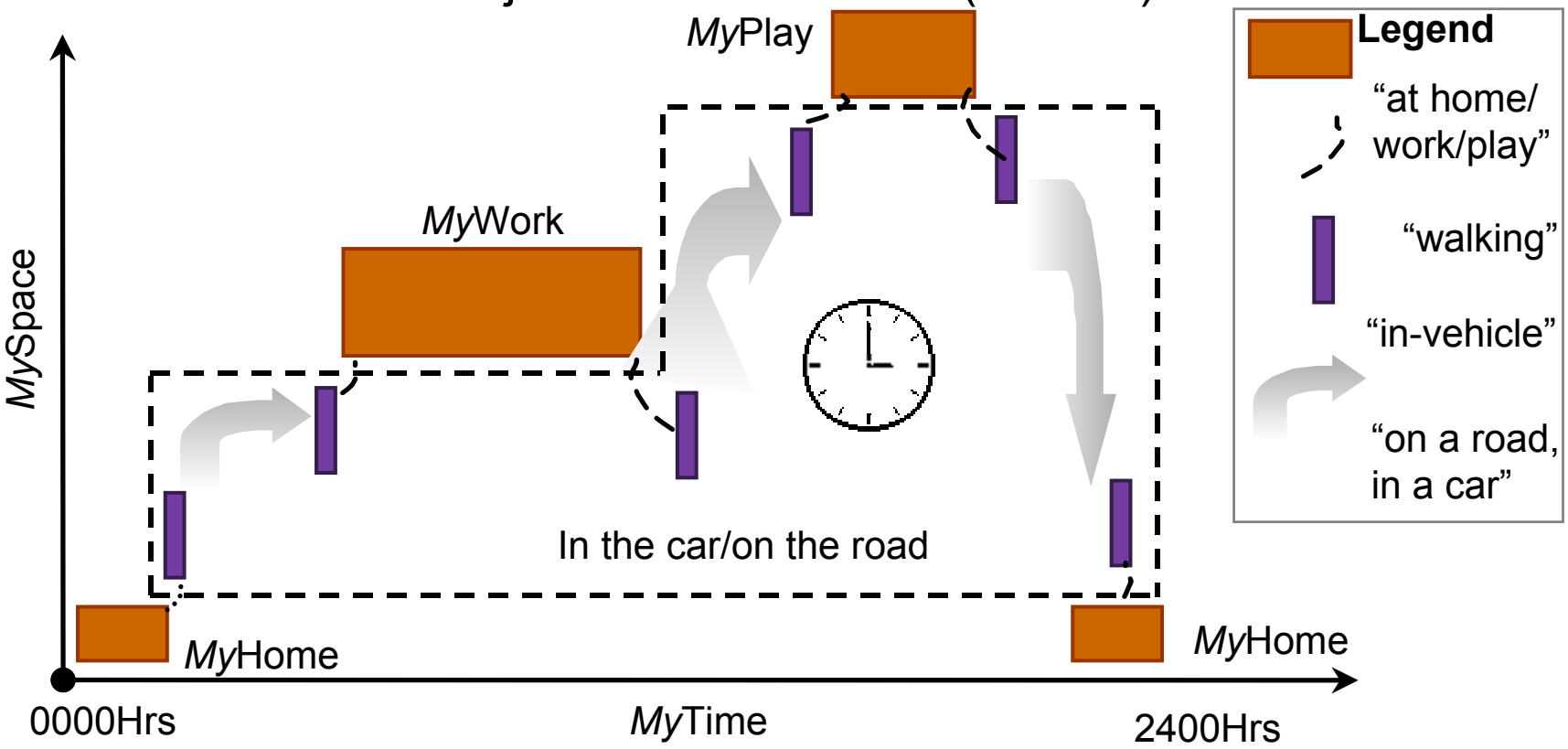
A working definition:

- A broad umbrella term that implies computers everywhere --- some visible, many "hidden-away," but all networked;
- Somewhat different from Ubiquitous which also implies everywhere but doesn't imply "hidden-away."

# Take one day in *My* life

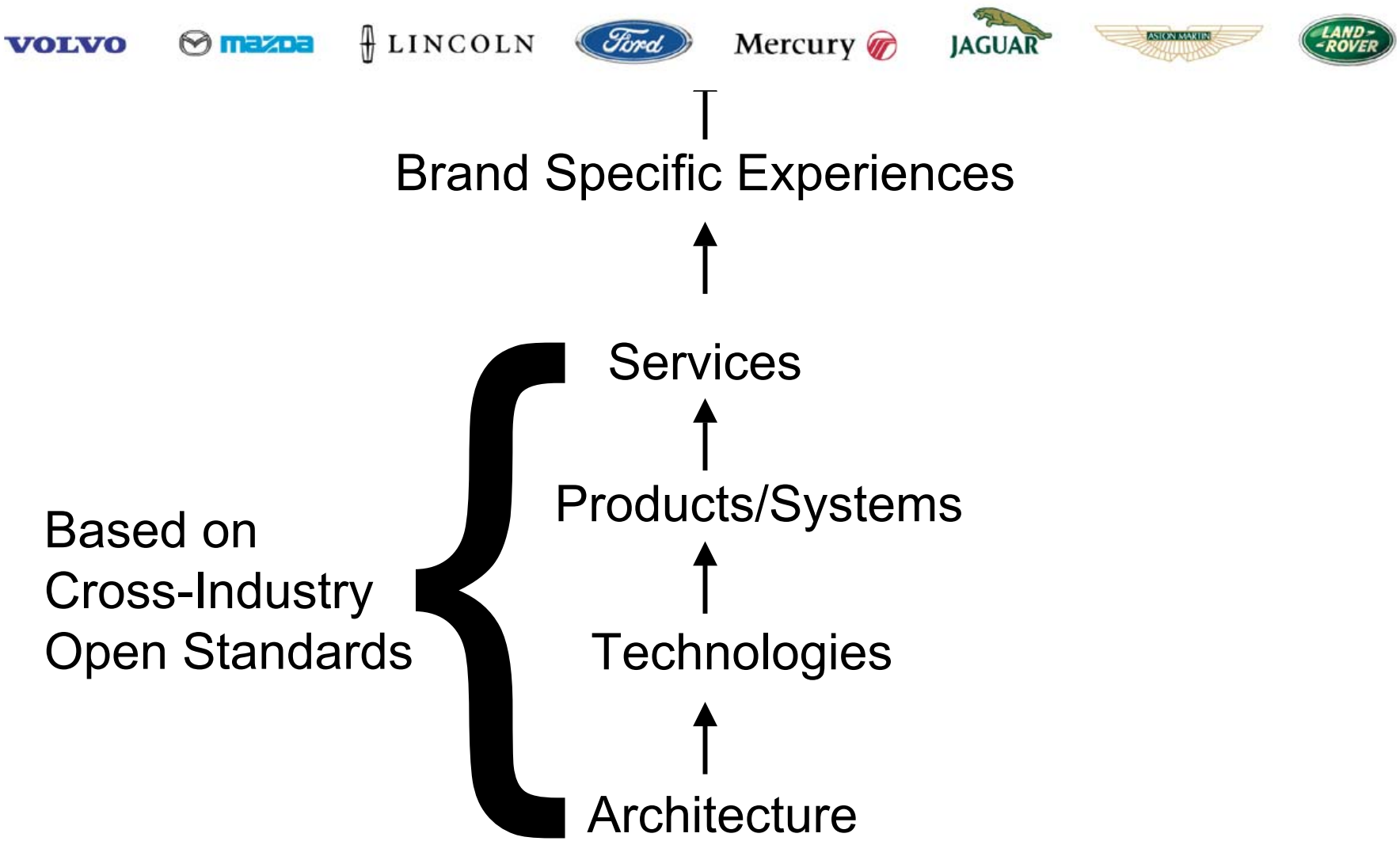
… there are numerous

disjoint transitions and (service) transactions




Pervasive Computing to the Consumer is about seamless (comfortable) experiences not about devices or services

# Automotive Consumer Experiences



# The Challenge of Service & System Design

## (The Demanding) External Environment

- Physically
  - Hash
  - Unpredictable
- Electronically required to be:
  - Reliable
  - "Always On"

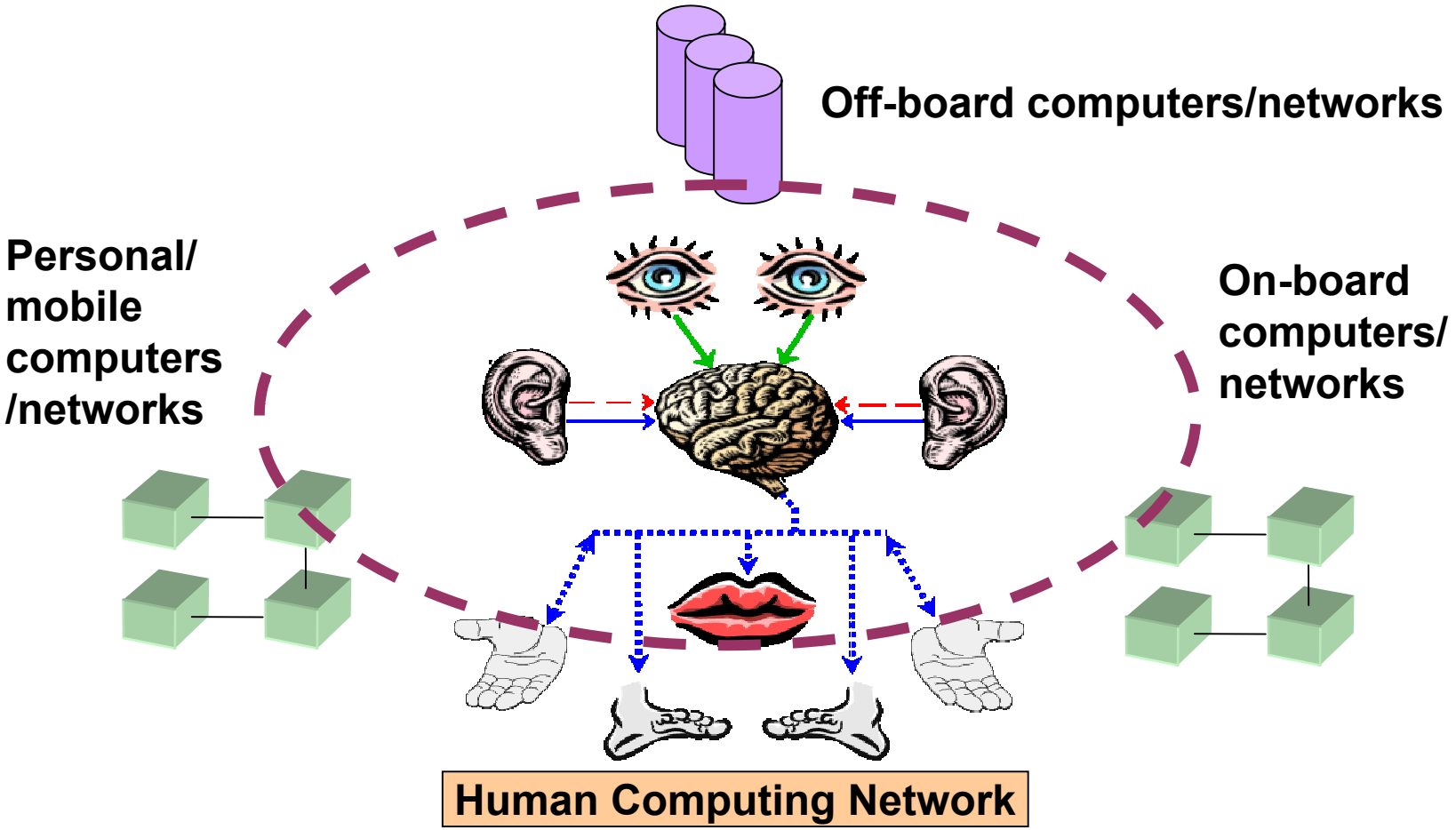
## (The Vehicle is a) Personal Environment

- A dining room --- drinks
- A living room --- books
- A *dressing* room
- A family room --- entertainment
- Mobile/transient in nature

## Internal Environment (is expected to be:)

- Safe, Secure, Private
- Comfortable and Convenient
  - Familiar and predictable
- Reliable, durable
- "Permanent"/installed in nature

# A Key Challenge for Usable Pervasive Computing: Computing with the human-in-the-loop



# A Brief History of the Automobile …

- Automotive Industry is about a 100 years old
- The first fifty years 1901-1950, say, was really just trying to get the driver and passengers from point A to point B reliably.
- Going from New York to LA was a major achievement. From an engineering standpoint the focus mostly component engineering.

# The Next Fifty Years of the Automobile System 1951-2000

- During the next fifty years 1951-2000, getting from A to B reliably was expected.
- Consumers looked for comfort, convenience, safety and security. Engineering began to take a total vehicle systems approach, optimizing over sub-systems such as powertrain systems, engine systems and braking systems --- to name a few. Note all these were physically in-vehicle sub-systems.

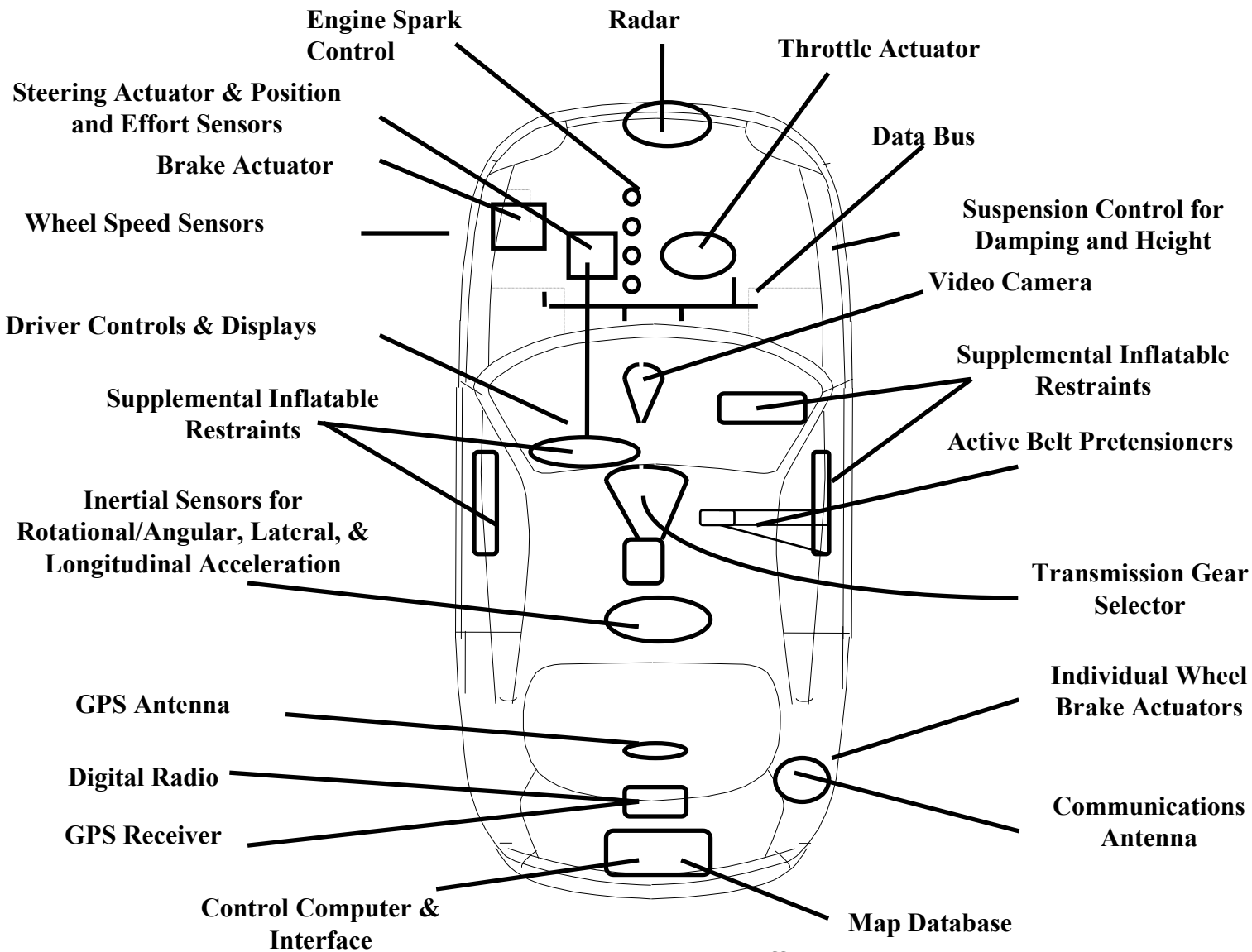
# The 21st Century Vehicle

What's in store for the next fifty years?

- The notion of a system and all its associated controls is rapidly going beyond the physical realm of a vehicle to include what may be off-board and what may be mobile.
- Optimizing across all these distributed systems will be essential
  - to make the vehicle lighter & more fuel efficient and
  - yet be able to offer an increasing range of personalized services to enhance the mobility experience.
- Most key electrical sub-systems of a vehicle will all be networked albeit with an "intranet" like protected zone (see following slides).

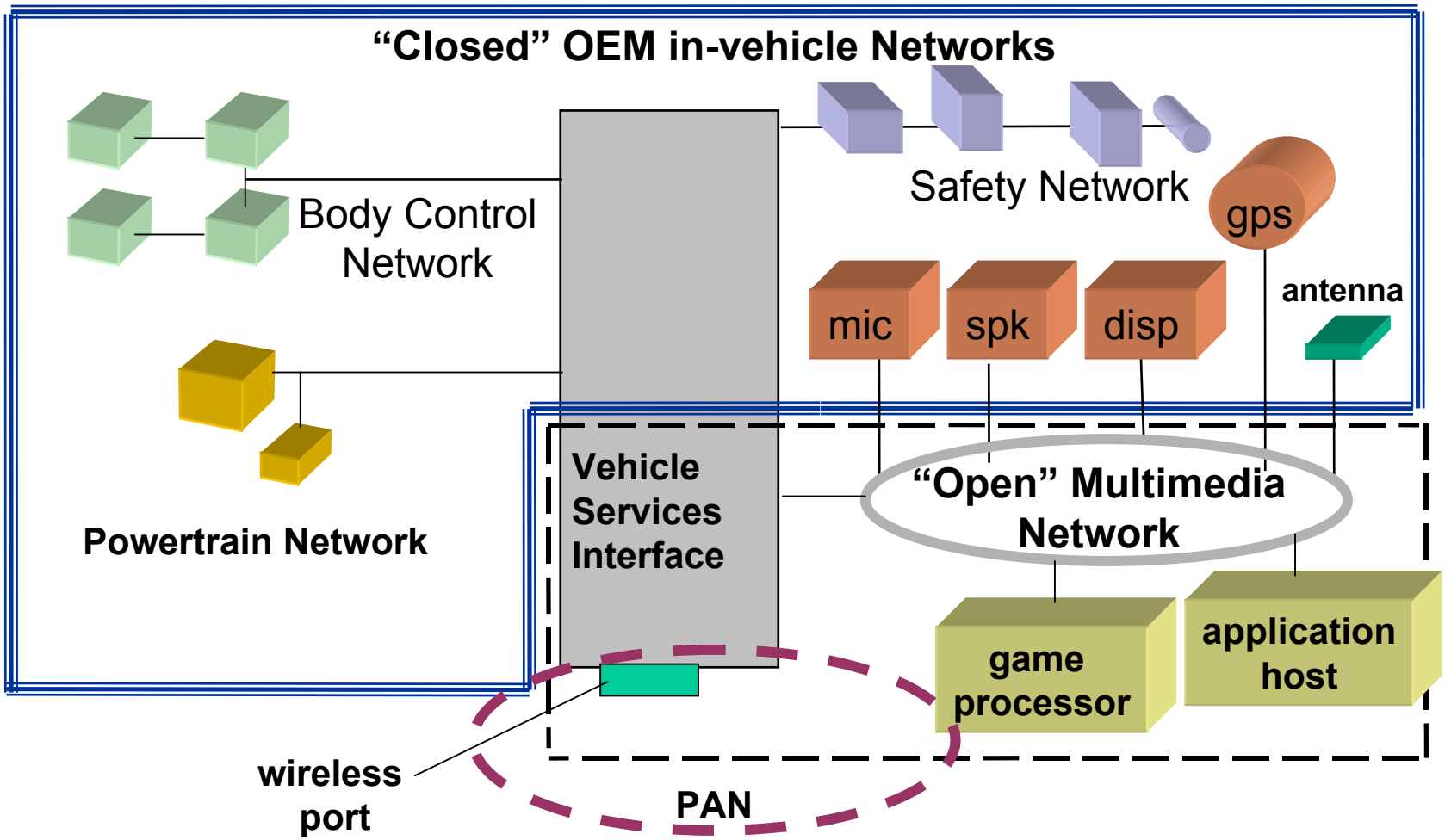
# Key sub-systems in an Automobile Electrical System

Drawing Courtesy Paul Nicastri, Ford Motor Company.

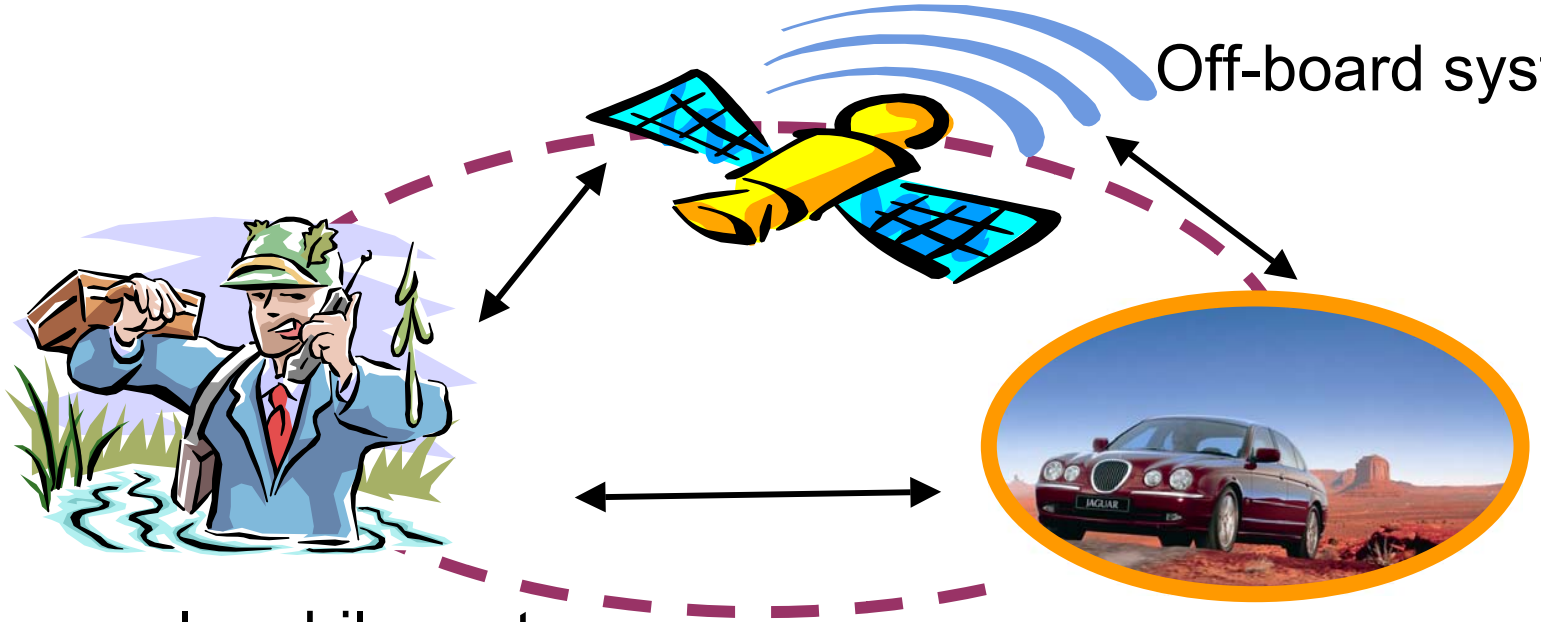



These on-board networked systems will interact with the off-board and mobile networks and systems (see next slide)

# In-Vehicle Local Area Networks (LANs), wireless LANS and Personal Area Networks (PANs).



# The Automobile System (Revised for the 21st Century …)

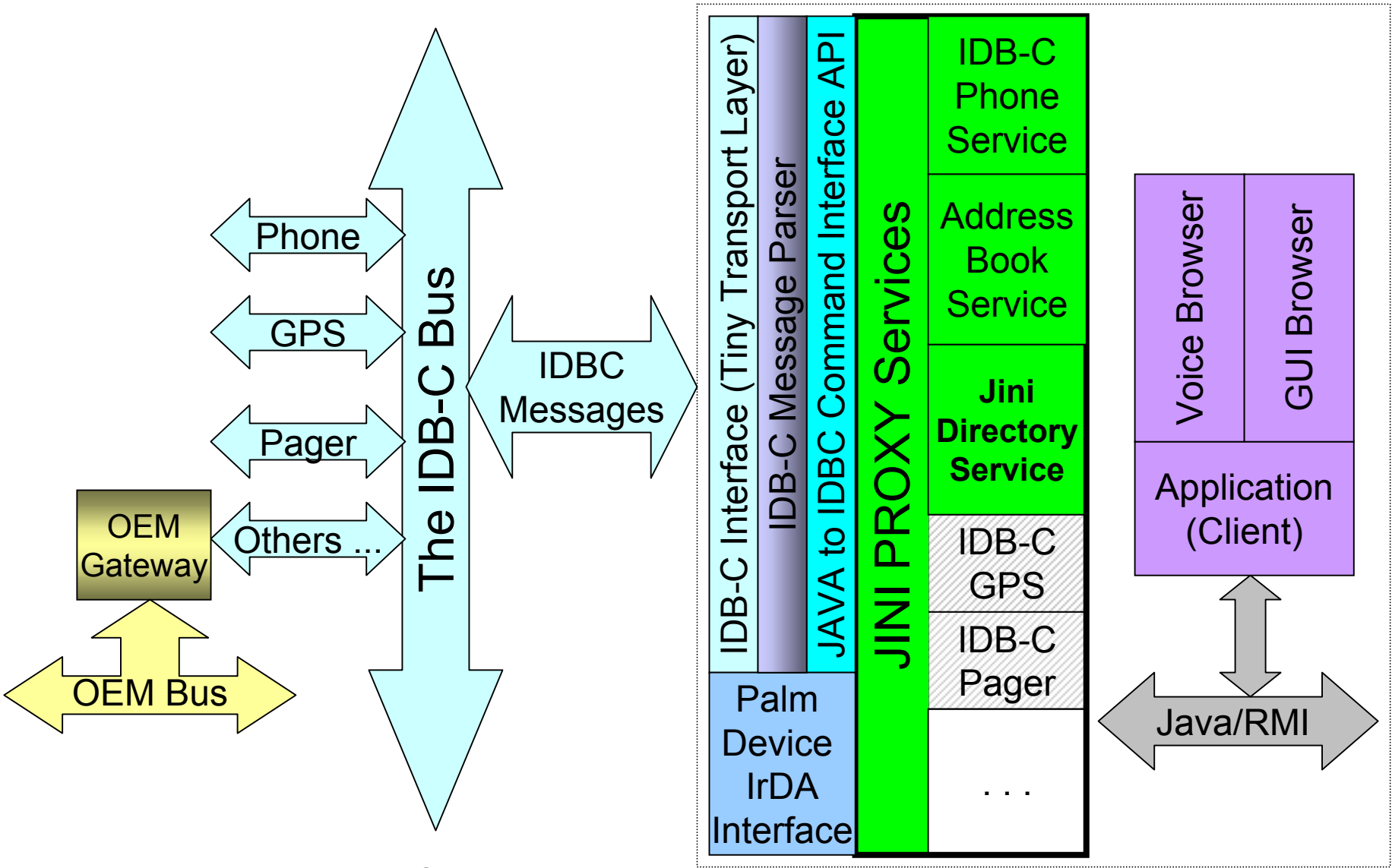



… will be a system resulting from optimized distributed (pervasive?) control, communication, computing. It will be one on which (ownership) experiences will be staged using services and systems spread across personal, off-board and in-vehicle systems.

# The evolution of in-vehicle computing on Ford vehicles

- Electronic Engine Control (EEC)-II --- 1978 --- Toshiba 12 bit processor --- 6 bit bytes (characters) --- Engine, Spark & Fuel control This was the only in-vehicle processor.
- EEC V --- Similar to an Intel 8096; Developed for Ford; 16 bit processor.
- PTEC --- Motorola PowerPC; 32 bit processor; Powertrain --- transmission + engine.
- Today (2001): 25-30 processors/high-end vehicle. These have remained steady for a while.
- The number of processors may increase a bit --- to handle Multimedia and Telematics --- but because these sub-systems depreciate rapidly much of the additional processing power will likely take a “plug & play” and/or personal wireless network form.

# Some Recent Experiments: The Java/Jini Vehicle Architecture




Source: 2000 Automotive Jini Project
Sun Microsystems --- Ford Motor Company

# Some Cross-Industry Standards Activities that Ford Motor Company in involved with:

- AMI-C (Automotive Multimedia Interface Collaboration)
- MOST Cooperation
- Bluetooth SIG / AEG
- OSGi (Open Services Gateway Interface)

# Why Standards are Essential - Not Just for Carmakers

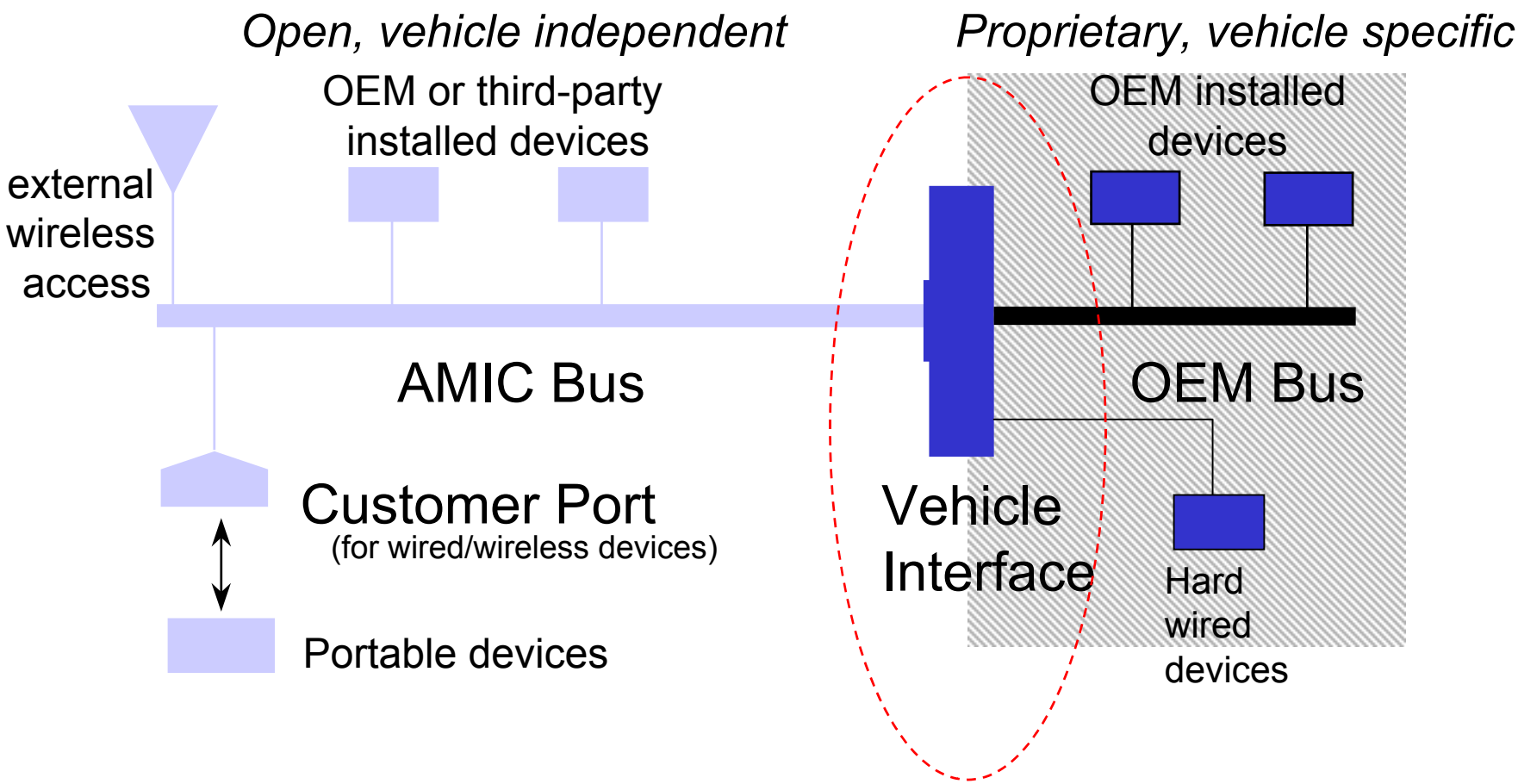
| For | Modularity | Backward Compatibility | Flexibility |
|---|---|---|---|
| **Consumers** | •Lower replacement costs.<br>•Easy to upgrade. | •Lower cost to upgrade.<br>•Larger choice of products. | •Easily adapted to personal needs.<br>•Easily expanded to a higher level of functional performance and features if desired. |
| **Carmakers** | •Easily Configured.<br>•Easier to test and validate.<br>•Wider range of options.<br>•Shorter time-to-market for new technologies. | •Updating new models easier at lower costs.<br>•Upgradeable older cars retain higher residual value. | •Wide set of features available from the dealer.<br>•Common, scalable system possible from low cost vehicles through luxury vehicles. |
| **Component Manufacturers** | •Provide similar components to many carmakers lowering developmental cost.<br>•Provide larger variety of components at lower incremental costs. | •Larger market for service parts.<br>•Minimizes obsolescence. | •Larger market for products across car makes.<br>•Greater opportunity to use common components in variety of system configurations. |
| **Service Providers** | •Easily added hardware to support new services offered.<br>•Easily upgradeable to new technology levels. | •Larger market for services offered.<br>•Lower cost of hardware needed. | •Easily configured for new service features and functions. |

Source: Ralph Robinson (rrobins2@ford.com) , AMI-C & Ford Motor Company

# The Automotive Multimedia Interface Collaboration (AMI-C)

- AMI-C (www.ami-c.org) is an organization of worldwide carmakers created to facilitate the development, promotion and standardization of electronic interfaces for automotive multimedia and telematics subsystems.
- Today, the members of AMI-C include the following companies and their designated affiliates:
  - Ø Fiat Auto
  - Ø Ford Motor Company
  - Ø General Motors
  - Ø Honda
  - Ø Nissan
  - Ø PSA Peugeot Citroen
  - Ø Renault
  - Ø Toyota

# AMI-C Vehicle Services Interface




The VSI presents a common interface to vehicle information and control functions across different makes and models.

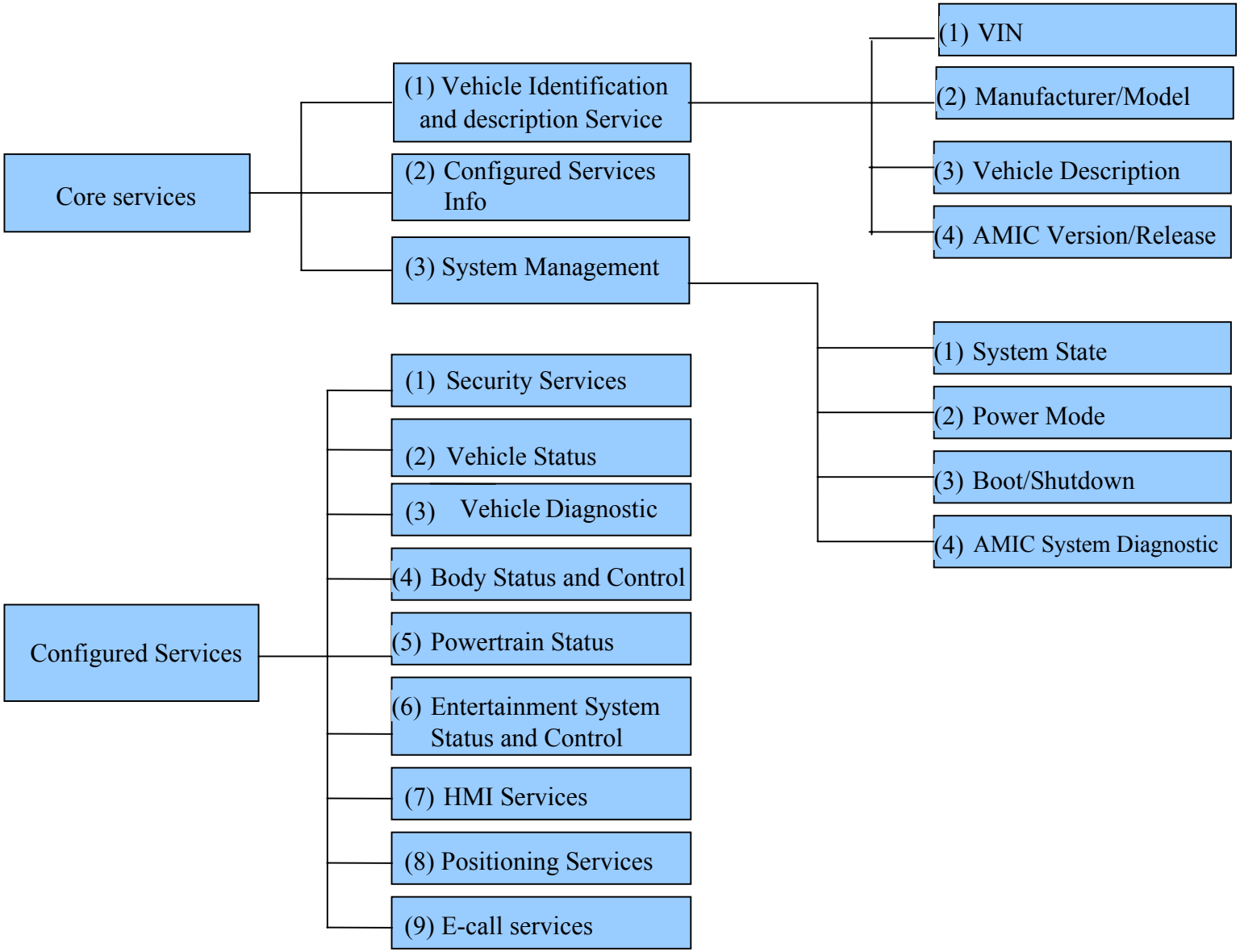
Source: Ed Nelson (enelson7@ford.com) , AMI-C & Ford Motor Company

# AMI-C Vehicle Services

- Core Services must be implemented for all vehicles
  - Identification and configuration information
  - Power management and System management
- Configured services are optional. They include:
  - vehicle status, (speed, fuel level, odometer, etc.),
  - body status and control (door locks, mirrors, seats, etc.),
  - diagnostics,
  - powertrain status,
  - entertainment system status and control, etc.
  - Human-Machine Interface (displays, speech, etc.)

Source: Ed Nelson, AMI-C & Ford Motor Company

# AMI-C Vehicle Services Interface Structure




Source: Ed Nelson, AMI-C & Ford Motor Company

# In Summary … What's Automotive?

Automotive involves

Vehicle Systems that are:

- Large Scale
- Complex
- Dynamic
- Robust, Reliable over –40 deg. C to + 135 deg. C
- Reliable & Durable --- 10 years / 150 K miles.
- Low Cost
- Efficiently Manufacturable
- Efficiently Maintainable

# Automotive also involves Processes

- Large, complex, globally distributed:
  - Logistical Systems
  - Financial Systems
  - Personnel Systems
  - Manufacturing Systems

All of which need to be scalable, flexible and need to be **Environmentally Sustainable.**

**Pervasive computing has a role to place in all these arenas.**

# Concluding Remarks

- Pervasive computing design needs to explicitly include the human-in-the-loop.
- Consumers are moving away from wanting to pay for assets to wanting pay for experiences --- experiences that are seamless.
- Services are a means (of staging experiences) not the end. Services need to be robust and must compensate for the shortcomings of the underlying technologies.
- Consumers want personalization --- at home, at work, at play and on the road.
- To get more intelligence the vehicle will increasingly rely on being networked to the mobile (personal) and external environment.
- Pervasive computing will be applicable in (automotive) products and associated services, as well as in the processes needed to create and maintain the products and services.